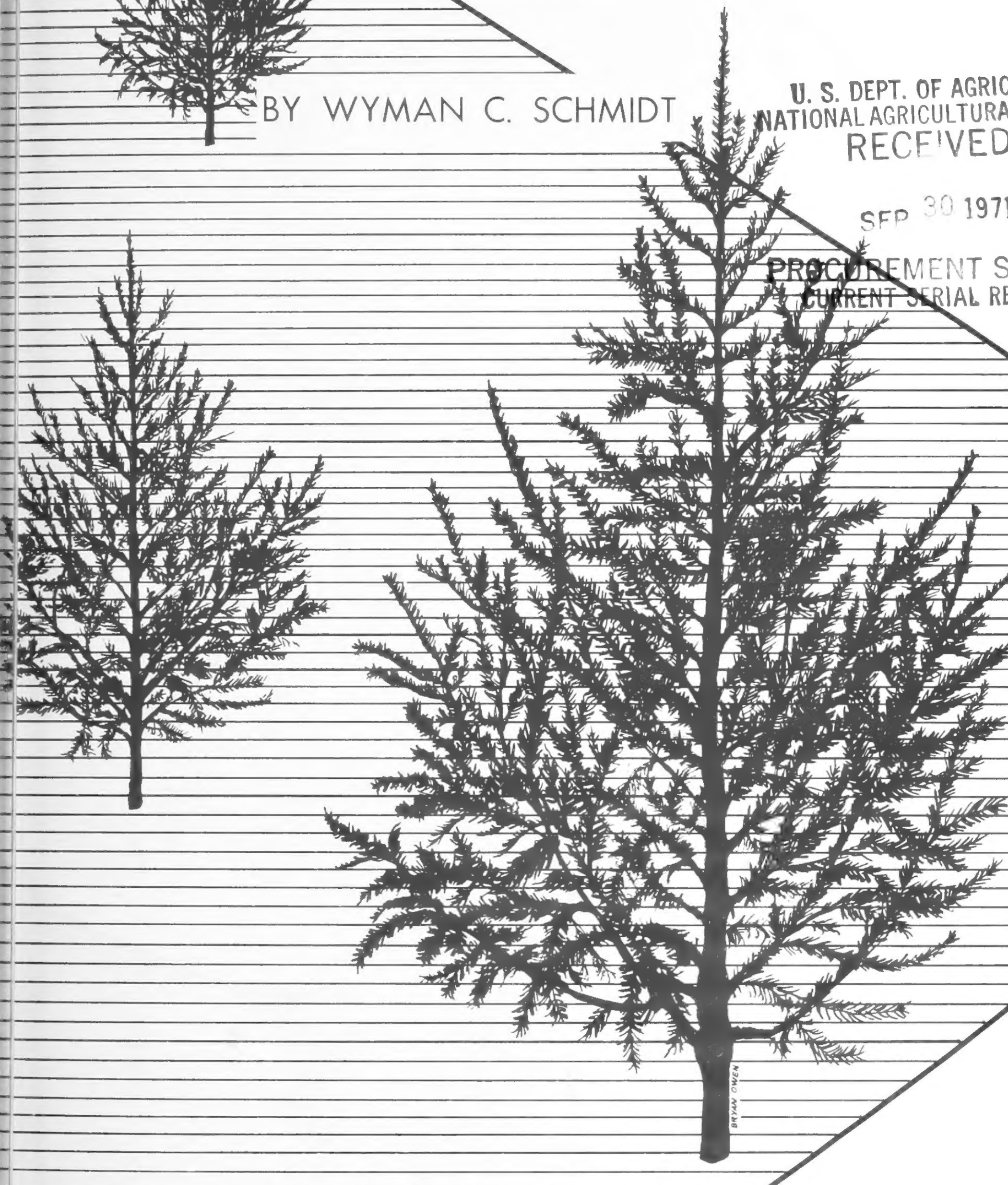
Christmas Tree Culture In Natural Stands Of Douglas-Fir In Montana

BY WYMAN C. SCHMIDT



USDA FOREST SERVICE
RESEARCH PAPER INT-84
1970

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
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The author acknowledges the work of B. M. Huey, A. L. Roe, K. N. Boe, and R. C. Shearer in designing, establishing, and collecting field data for this study and the cooperation of Gilbert Kries, Don and Winton Weydemeyer, as well as the Anaconda Forest Products, Northern Pacific Railroad, Montana State Forester, and the Flathead, Kootenai, and Lolo National Forests in the use of their lands.

USDA Forest Service
Research Paper INT-84
December 1970

CHRISTMAS TREE CULTURE IN NATURAL STANDS OF DOUGLAS-FIR IN MONTANA

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ABSTRACT

A 10-year study of three commonly used Christmas tree culture methods--stump culture, basal pruning, and thicket thinning--in natural stands of Douglas-fir in Montana showed that quantity and quality of trees can be increased. Stump culture, featuring upturned branches or adventitious shoots, produced large high quality trees rapidly. Trees originating from branch turnups reached larger sizes earlier than those from shoots. Basal pruning reduced height growth in direct proportion to the amount of crown removal for 5 to 10 years but demonstrated no corresponding increase in quantity or quality of the trees produced on the relatively low quality sites represented in the study. Douglas-fir thickets produced many Christmas trees in the initial thinnings and subsequent harvests, but they were small medium quality trees. Light to moderate thinnings maintained the stand in better condition for future production than heavy thinning.

INTRODUCTION

Douglas-fir *(Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco) still reigns as king of the Christmas tree industry in the northern Rockies, accounting for over 80 percent of the Christmas trees harvested. Montana alone supplied over 80 million Christmas trees in the last three decades--practically all of them Douglas-fir (Benson 1967). Its harvests increased rapidly during the 1930's and 1940's, reaching a peak in 1956 when 4.2 million trees were exported from the State (Wilson 1957); since then, harvests have declined to 2 million trees annually (Benson 1965). However, Montana still accounts for about 5 percent of the trees sold in the United States, but this amounts to less than half of its share of the market during the 1940's when it supplied over 10 percent of the Nation's wants.

Several factors probably account for this decline. Disease and insects, such as needlecast disease *(Rhabdocline pseudotsugae* Syd.), needle midge insects *(Cecidomyia* sp.), and Cooley's gall louse *(Adelges cooleyi* Gill.), periodically flare up and reduce tree quality (Roe 1948). Spruce budworm *(Choristoneura* sp.) populations built up in the 1950's and still continue to defoliate extensive areas of Douglas-fir. All of these pests reduce the number of good quality trees available for the increasingly competitive Christmas tree market. Artificial Christmas trees have increased nationwide and may also be a factor involved in the decline of Montana tree sales.

Douglas-fir trees have many inherent desirable Christmas tree qualities--soft short needles, deep green color, pleasant aroma, a "natural" look, good needle retention after cutting, and good shipping characteristics. As a result, the demand for Douglas-fir trees has always been strong and they command a good price, sometimes twice as much as similar quality pine trees (Wright 1965). However, an increasing number of buyers are demanding trees with crowns that are denser than crowns of trees commonly found in wild stands. As a result, cultured trees are commanding an increasing share of the market--uncultured trees from natural, wild stands dropped from 57 percent of the total shipments from the Pacific Northwest in 1959 to 24 percent in 1964 (Douglass 1965).

Christmas tree producers in the Northern Rockies seek to promote both the area and the species in the eyes of the buyer by increasing the quality of trees reaching the market. To do this, they are using numerous cultural methods in their natural stands.

However, many growers are uncertain whether they are benefiting from using such methods or which methods yield the greatest number of marketable trees on their site conditions. This study was designed to determine if these commonly used cultural treatments actually do increase the total production as well as the quality of Christmas trees in natural Douglas-fir stands.

CULTURAL METHODS TESTED

Three types of cultural methods--stump culture, basal pruning, and thicket thinning--were tested over a 10-year period starting in the late 1940's. Five study plots in western Montana near Eureka, Kalispell, Greenough, Plains, and Lolo (fig. 1) provided a cross section of stand and site conditions. Tree quality and size, based on Hutchison's and Huey's (1949) standards for Montana,[1] and growth data were collected 5 and 10 years after the treatments.

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[1]The Christmas tree grades used in this study--premium, standard, utility, and cull--are very similar to the present grades (U.S. Dep. Agr. 1962)--premium, choice, standard, and cull--respectively.

Figure 1.--Location of test plots used in study.

Stump Culture

Stump culture is an intriguing practice that likely developed more by chance than by design. If live branches are left on the stumps of small Douglas-fir trees after cutting, the stumps often remain alive and produce new trees from adventitious shoots or branch turnups. Using proper culture treatment, these have potential value as Christmas trees. This study phase had two primary objectives: (1) to determine if stump culture treatments favoring either branch turnups or adventitious shoots were equally effective in producing Christmas trees, and (2) to determine when stumps could be cultured most effectively; 0, 1, 2, or 3 years after the original tree was cut.

The original trees, which averaged 12 to 16 feet in height, were cut with a handsaw about 3 to 4 feet above ground and 3 to 4 inches above a good branch whorl. Stumps treated to favor branch turnups were trimmed to feature one large vigorous branch in the top whorl leaving 5 to 7 vigorous, alternate branches in the lower whorls. Stumps treated to favor adventitious shoots were trimmed so that all the branches on the upper 18 inches, and all but 5 to 7 vigorous, alternate branches in the lower whorls were removed (fig. 2).

Five to 7 years later, most of the featured branches had turned up, or adventitious shoots had formed and whorls were developing. At that time, excess branches,

Figure 2.--Two stumps were cultured to produce Christmas trees: left stump was treated to favor adventitious shoots; right stump was treated to favor a branch turnup.

which were competing for space with the featured turnups and shoots, were removed. In addition, about half of the lower branches of the new turnups were pruned to reduce excessive height growth.

A paired-tree design method was used: stumps treated to favor branch turnups were matched with those treated to favor adventitious shoots. This same pairing method was used in each of 4 successive years following the cutting of the original trees. Included were 6 pairs of trees in each of 4 years at 5 locations--making a total of 120 pairs of trees. All treatments were randomly assigned.

Basal Pruning

Low-density crown, due to excessive distances between whorls, was felt to be responsible for reducing the quality of many trees. Five different basal pruning methods applied once at the start of this study were tested to determine if height growth, and as a result, distance between whorls could be reduced and if higher quality trees would result. The treatments were:

1. Remove lower two-thirds of the green crown

2. Remove lower one-half of the green crown

3. Remove one-half of the green crown from midtree, leaving lower branches for future stump culture (fig. 3)

4. Remove crown along two-thirds of one side of the green crown and strip off one inch or more of the bark

5. Shear buds from leaders and laterals

A paired-tree design, with one of the pair randomly chosen for pruning and the other used as a check, was used to determine pruning effects (fig. 4). Six pairs of trees for each of the five treatments at five locations--a total of 150 pairs--comprised the sample. When treated, the trees averaged 12 feet in height, ranging from 10 feet on the plot near Eureka to 14 feet on the plot near Lolo.

Figure 3.--Shown above is a natural Douglas-fir tree before and after one-half of the live crown was pruned from midtree. Lower branches were retained for future stump culture.

Thicket Thinning

Douglas-fir often grows in thickets dense enough to severely restrict crown development on individual trees. Consequently, their marketability as Christmas trees is reduced. We sought to determine how three different levels of thinning affect the quantity and quality of trees that could be harvested in these thickets, both initially and subsequently. The three thinning levels were based primarily on ocular estimates of light, medium, and heavy, using the following criteria:

1. Light.--Badly deformed Douglas-fir and all other species removed plus a few merchantable Christmas trees. Residual stand was still crowded with an average spacing of less than 2 feet between trees.

2. Medium.--Badly deformed Douglas-fir and all other species removed plus some merchantable Christmas trees. Residual stand was less crowded than above but there was still some side shading.

3. Heavy.--Badly deformed Douglas-fir and all other species removed plus many merchantable Christmas trees. Residual stand was moderately open with very little side shading.

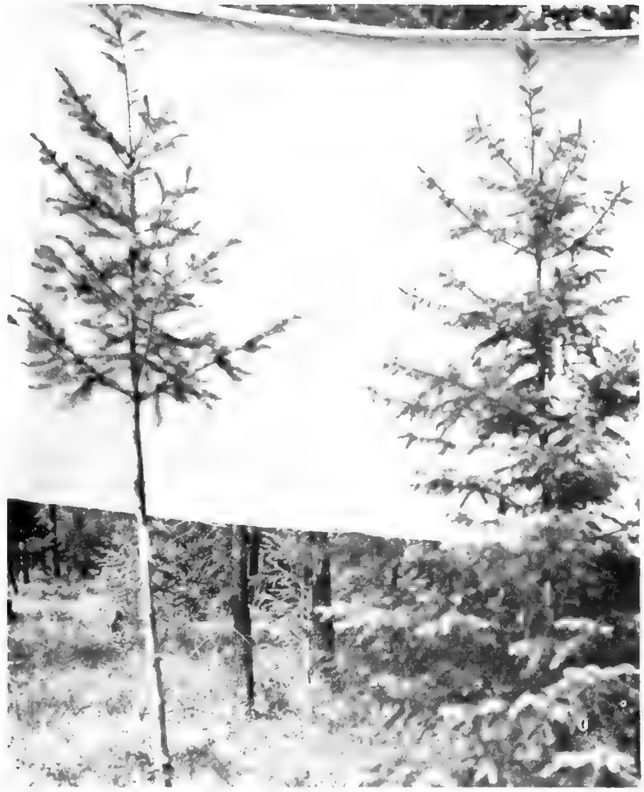

Figure 4.--Paired trees were used to determine effects of basal pruning on Christmas tree production: the lower two-thirds of the green crown was removed on the tree on the left; the tree on the right served as a check.

All three thinning treatments were installed at each of five locations, making a total of 15 plots. All plots were 1/100 acre in size and were surrounded with a 15- to 20-foot wide isolation zone. Treatments were randomly chosen. Dominant and codominant trees in the thickets averaged 15- to 19-feet tall when the study was started.

STUDY RESULTS

Stump culture was the most successful treatment tested in this study, producing large numbers of trees that were above average in both quality and size. None of the pruning methods significantly (t-test, 1 percent confidence level) increased total Christmas tree production. Heavy thinnings produced the most trees initially, but 10 years later the light and moderately thinned areas still had three times as many trees capable of producing Christmas trees.

Stump Culture

A comparison of the two types of stump tree origins--branch turnups and adventitious shoots--demonstrated that over three times (significant at the 1 percent level by t-test) as many turnups developed into Christmas trees as shoots. As shown in table 1, 59 percent of the stumps treated to favor branch turnups produced Christmas trees. Meanwhile, 17 percent of the stumps treated to favor adventitious shoots produced Christmas trees.

Year of stump treatment had no apparent effect on tree production because the number of trees produced from branch turnups varied only slightly by years (table 1). Production from adventitious shoots was slightly more erratic, but no pattern was apparent.

Table 1.--*Percentile Christmas tree production from branch turnups and adventitious shoots by year of treatment and tree grade*[1]

Year treated[2]	Christmas tree grade			Total
	Premium	Standard	Utility	
		BRANCH TURNUPS		
0	7	27	23	57
1	17	13	30	60
2	7	23	33	63
3	10	20	27	57
Average	10	21	28	59
		ADVENTITIOUS SHOOTS		
0	0	3	20	23
1	0	3	4	7
2	0	0	13	13
3	10	10	3	23
Average	3	4	10	17

[1]Expressed as a percent of total possible.
[2]Number of years after the original tree was cut.

The relation of tree grades to the actual number of Christmas trees produced was nearly the same for branch turnups and adventitious shoots. However, there was a tendency toward better grades being produced from branch turnups, as reflected in this tabulation:

Grade	*Branch turnups* (Percent)	*Adventitious shoots* (Percent)
Premium	17	15
Standard	35	25
Utility	48	60
Total	100	100

Tree production was best on the Eureka and Kalispell areas but the differences, by areas, were not too pronounced, as shown in the following tabulation:

Location	*Branch turnups* (Percent)	*Adventitious shoots* (Percent)
Eureka	71	21
Kalispell	62	29
Greenough	62	17
Plains	50	17
Lolo	50	0
Average	59	17

Figure 5.--Douglas-fir stump 1 year after a Christmas tree was harvested from the top portion. The branch on the left has already turned up and all but five vigorous branches in the lower whorls have been removed to give the turnup room to develop into another Christmas tree.

The lack of Christmas trees produced from shoots on the Lolo site was due primarily to the severe competition branch turnups offered the shoots on this area. In addition, those shoots that did not have turnup competition grew too fast for satisfactory Christmas tree development.

Year of treatment had no apparent effect on the sizes of trees produced from either turnups or shoots. The data are somewhat erratic, but the distribution in the different size classes was similar from year to year (table 2).

Branch turnups produced large trees rapidly (fig. 5). Over a third of the merchantable trees produced from turnups were in the 10- and 12-foot classes (table 2). Trees from adventitious shoots were smaller than those from turnups. Nearly three-fourths of the shoot trees were in the 2- and 4-foot classes.

Nearly three-fourths of the stumps produced at least one adventitious shoot--the average was $3\frac{1}{2}$ per stump. Stump treatments delayed the longest produced the most shoots, ranging from a low of 46 percent of the stumps treated in the first year to a high of 90 percent of those treated 3 years later (table 3). This apparently reflected the extra vigor in stumps that still had their full branch complement. Trees in most of the areas responded similarly except for those in the Eureka area where less than half as many of the stumps produced shoots.

Excessive growth, particularly on the Greenough, Plains, and Lolo plots, caused many of the shoot and turnup trees to be classed as culls. Insufficient development, crowding of shoots by turnups, competition from adjacent trees, lack of symmetry, and needle blight accounted for most of the other culls.

Basal Pruning

All of the pruning treatments significantly (t-test, 1 percent confidence level) reduced height and diameter growth for at least the first 5 years after pruning and three of the five treatments reduced such growth during the 5- to 10-year period (table 4). Height growth reduction was directly proportional to the amount of live crown removed.

Table 2.--*Percentile Christmas tree production from branch turnups and adventitious shoots by year of treatment and size*[1]

Year treated[2]	Size classes: 2- and 4-ft.	Size classes: 6- and 8-ft.	Size classes: 10- and 12-ft.	Total
		BRANCH TURNUPS		
0	14	17	26	57
1	20	23	17	60
2	10	33	20	63
3	20	17	20	57
Average	16	22	21	59
		ADVENTITIOUS SHOOTS		
0	17	6	0	23
1	7	0	0	7
2	7	6	0	13
3	17	6	0	23
Average	12	5	0	17

[1]Expressed as a percent of total possible.
[2]Number of years after the original tree was cut.

Table 3.--*Percent of stumps with adventitious shoots by area and year of stump culture treatment*

Area	Year treated[1]: 0	1	2	3	Average
Eureka	17	33	33	50	33
Kalispell	66	66	100	100	83
Greenough	66	50	100	100	79
Plains	66	66	100	100	83
Lolo	17	83	100	100	75
Average	46	60	87	90	71

[1]Number of years after the original tree was cut.

Table 4.--*Growth of sample trees in the first and second 5-year periods after pruning*

Treatment[1]	Height: Average annual growth of unpruned trees, 0-10 years	Height: Pruned trees[2], 0-5 years	Height: Pruned trees[2], 5-10 years	Diameter: Average annual growth of unpruned trees, 0-10 years	Diameter: Pruned trees[2], 0-5 years	Diameter: Pruned trees[2], 5-10 years
	Feet	*Percent*	*Percent*	*Inches*	*Percent*	*Percent*
1	1.2	48**	76**	0.21	50**	69**
2	1.2	67**	88**	.22	69**	81**
3	1.2	76**	88**	.21	74**	78**
4	1.1	82**	97	.20	86**	105
5	.9	86**	114	.17	84**	109

[1]For description of treatments, see page 3.
[2]Expressed as a percent of the unpruned tree growth.
**Significantly different than the unpruned paired trees as determined by "t" tests (1 percent confidence level).

The most severe pruning treatment--where the lower two-thirds of the green crown was removed--reduced height growth in the first 5 years to about half of its previous rate. The other pruning treatments demonstrated similar but proportionately less reduction. Diameter growth responded the same as height.

The trees gradually recuperated from the effects of pruning. Although all treatments reduced growth considerably the first 5 years after pruning, only the more severe pruning had any significant (t-test, 1 percent confidence level) effect during the second 5-year period. Even the most severely pruned trees gradually regained their normal height growth--from about 50 percent of normal in the first 5 years to 76 percent in the second 5-year period. Diameter growth rates returned to normal more slowly than did height growth rates.

Production was nearly identical on pruned and unpruned trees (table 5). The two treatments in which half of the crown was removed appeared to increase production during the first 5 years after treatment, but these differences were not statistically significant because of considerable variation in response. About one-third of the sample trees produced Christmas trees during the first 5-year period after treatment and another third during the succeeding 5 years.

No differences in tree grade could be detected between pruned and unpruned trees using any of the pruning methods. Approximately one-third of the merchantable Christmas trees produced were standard-grade trees and the other two-thirds were utility-grade trees (table 6). Only a few premium trees were produced in all of the paired samples.

About one-third of all the trees were classed as culls. The following accounted for about 90 percent of the culling: crowns were too open, 70 percent; and trees damaged by Christmas tree blight, 20 percent. Suppression, deformities, and poor balance caused the remainder of the culling. Mortality was light in both pruned and unpruned trees. Only 4 percent of the pruned trees and 1 percent of the unpruned trees died during 10 years following treatment.

About two-thirds of the merchantable trees produced were in the 6- and 8-foot classes (table 7). Most of the others were in the 2- and 4-foot classes; 10- and 12-foot trees were rare.

Table 5.--*Percentile Christmas tree production on pruned and unpruned trees during the first and second 5-year periods after treatment*[1]

Pruning treatment[2]	First 5 years		Second 5 years	
	Pruned	Unpruned	Pruned	Unpruned
1	33	33	71	71
2	50	33	71	67
3	50	17	75	62
4	20	20	50	50
5	27	43	38	58
Average	36	29	61	62

[1]Expressed as a percent of total possible.
[2]For description of treatments, see page 3.

Table 6.--*Percentile Christmas tree production by grade and treatment during the 10 years after treatment*[1]

Pruning treatment[2]	Christmas tree grade							
	Premium		Standard		Utility		Cull or dead	
	Pruned	Unpruned	Pruned	Unpruned	Pruned	Unpruned	Pruned	Unpruned
1	4	0	12	29	54	42	30	29
2	0	0	25	21	46	46	29	33
3	0	0	33	21	42	42	25	37
4	4	0	17	12	29	38	50	50
5	0	0	21	17	17	42	62	41
Average	2	0	22	20	37	42	39	38

[1]Expressed as a percent of total possible.
[2]For description of treatments, see page 3.

Table 7.--*Percentile Christmas tree production by size and treatment during the 10 years after treatment*[1]

Pruning treatment[2]	Christmas tree size classes					
	2- and 4-ft.		6- and 8-ft.		10- and 12-ft.	
	Pruned	Unpruned	Pruned	Unpruned	Pruned	Unpruned
1	21	4	50	58	0	8
2	29	17	42	46	0	4
3	29	12	38	50	8	0
4	17	12	33	38	0	0
5	17	29	21	29	0	0
Average	22	15	37	44	2	3

[1]Expressed as a percent of total possible.
[2]For description of treatments, see page 3.

Table 8.--*Percentile Christmas tree production by grade and size at different locations*[1]

Location[2]	Total	Grade			Size classes		
		Premium	Standard	Utility	2- and 4-ft.	6- and 8-ft.	10- and 12-ft.
Eureka	70	2	30	38	37	33	0
Kalispell	75	2	23	50	18	55	2
Greenough	55	0	20	35	12	38	5
Plains	45	0	10	35	8	35	2
Average	61	1	21	39	19	40	2

[1]Expressed as a percent of total possible.
[2]Ten-year production records for the Lolo area are not complete.

The height growth reduction caused by the pruning apparently resulted in smaller merchantable tree sizes (table 7). The total number of merchantable trees that fell in the 2- through 8-foot classes were identical on pruned and unpruned trees. However, more of the pruned trees fell in the 2- and 4-foot classes and fewer in 6- and 8-foot classes than the unpruned.

Eureka and Kalispell, the two northernmost study areas, produced the most Christmas trees. Nearly three-fourths of the total number of potential Christmas trees on these two areas reached merchantability during the 10-year study period compared to about one-half of the potential trees at Greenough and Plains (table 8). In addition, tree quality was also best at these two northern areas. About twice as many standard- or premium-grade trees were produced there as at Greenough and Plains. Production of utility-grade trees was about the same on all of the areas.

Thicket Thinning

Total Christmas tree production from the thicket thinnings was directly proportional to the number of trees per acre in the original stand. Between 7 and 8 percent of the original stands, regardless of thinning treatment, produced merchantable Christmas trees sometime during the 10-year study period, either in the initial or subsequent harvests (table 9). Thus, the thickets that had the most trees per acre initially produced the greatest total number of Christmas trees.

Production from subsequent harvests was directly related to the number of trees left after thinning. About 8 percent of the reserve stand produced Christmas trees in the 10-year period following thinning (table 9).

During the first 10 years, the most pronounced effect of different thinning intensities was the shift in the time of harvest (table 9). Most of the Christmas trees on the heavily thinned plots came from the initial thinning, while in the lightly thinned plots, nearly all of them came from subsequent harvests. Production on the medium thinnings was more evenly distributed during the study period.

No differences in tree grade or size could be detected between the three thinning treatments or on the different areas. Over half of the trees were standard grade, and most of the remainder were utility grade. Only 4 percent were premium-grade trees. Over three-fourths of the trees were in the 2- and 4-foot classes (table 10).

Table 9.--*Christmas tree production (per acre) from initial thinnings and subsequent harvests*

Thinning level	Stand density: Before thinning	Stand density: After thinning	Christmas tree production: From initial thinning	Christmas tree production: From subsequent harvests	Christmas tree production: Total
Light	15,100	12,300	80	980	1,060
Medium	12,920	9,600	200	820	1,020
Heavy	17,160	6,800	880	440	1,320
Average	15,060	9,567	386	747	1,133

Table 10.--*Percentile Christmas trees produced in thickets thinned to three different levels according to grade and size*

Thinning treatment	Tree grade: Premium	Tree grade: Standard	Tree grade: Utility	Height classes: 2-ft.	Height classes: 4-ft.	Height classes: 6-ft.	Height classes: 8-ft.
Light	8	59	33	31	43	18	8
Medium	0	46	54	27	55	16	2
Heavy	5	77	18	14	63	23	0
Average	4	61	35	24	54	19	3

Nearly all of the Christmas tree production came from dominant or codominant trees of good and fair vigor--96 percent of the merchantable Christmas trees were classified either dominant or codominant, while 70 percent were of good vigor and 29 percent of fair vigor when the study was initiated. These figures were essentially the same for all three thinning intensities.

Stand vigor declined under all three thinning intensities. During the first 6 years after thinning, 28 percent of the trees dropped at least one vigor class; i.e., from good to fair or fair to poor, while only 5 percent of the trees increased in vigor. The remaining high percentage (67 percent) of trees showing "no change" is somewhat deceiving. Most of these trees were of poor vigor at the start of the study; thus, there was no way for them to drop into a lower vigor class. In general, good vigor trees maintained their vigor; fair vigor trees declined; and poor vigor trees died or barely stayed alive. Differences between thinning treatments were minor.

Crown classes showed the same trend as vigor. Over a third of the trees dropped into lower crown classes; i.e., from dominant to codominant, codominant to intermediate, or intermediate to suppressed. Only 1 percent increased their crown position. Most of the trees that did not change crown class were suppressed trees that could not drop into a lower classification.

Records are not complete for the last remeasurement; but where recorded, vigor and crown class continued to decline.

Mortality started early and continued throughout the entire study period. Approximately one-fourth of all the "leave" trees in each thinning treatment died during the 10-year period after thinning (table 11).

Table 11.--*Accumulative mortality on thicket thinning treatments 3, 5, and 10 years after thinning*[1] [2]

Thinning treatment	3 years	5 years	10 years
Light	3	13	26
Medium	1	17	28
Heavy	4	17	23
Average	3	15	26

[1]Expressed as a percent of the reserve stand.
[2]The number of years is only approximate because of different measurement schedules.

Suppressed, poor vigor trees accounted for nearly all of the mortality. Dominant trees of good vigor made up only a small portion of the mortality during the study period, as shown in the following tabulations.

Crown class	*Mortality* (*Percent of total*)
Dominant	1
Codominant	5
Intermediate	26
Suppressed	68
Total	100

Vigor class	*Mortality* (*Percent of total*)
Good	4
Fair	14
Poor	82
Total	100

Although heavy thinnings produced more Christmas trees in the first 10 years, the possibilities of future production were better on the medium and lightly thinned areas. They still had about three times as many dominant and codominant trees and twice as many trees of good or fair vigor as did the heavily thinned areas (table 12).

Table 12.--*Crown and vigor classification of the residual stands 10 years after the original thinnings*

Thinning treatment	Total residual stand	Crown class				Vigor class		
		Dominant	Codominant	Intermediate	Suppressed	Good	Fair	Poor
	Trees per acre							
Light	7,820	220	1,160	2,320	4,120	460	3,140	4,220
Medium	5,920	240	920	1,760	3,000	600	2,200	3,120
Heavy	4,720	60	380	1,420	2,860	180	1,240	3,300
Average	6,153	173	820	1,833	3,327	413	2,193	3,547

CONCLUSIONS AND RECOMMENDATIONS

Cultural treatments can increase Christmas tree production in natural stands of Douglas-fir. The results from this study should encourage the use of stump culture treatments, discount the value of single pruning treatments on many Christmas tree sites, but encourage frequent, light to moderate thinnings in thickets.

Stump culture produced large, high quality Christmas trees rapidly. In this study, a higher percentage of premium quality trees were produced from stump culture than from any other treatment. Of the stumps treated to feature branch turnups, 60 percent produced merchantable trees within the 10-year period after the original tree was cut. Treatment to favor adventitious shoots also produced Christmas trees, but treatment to favor branch turnups outproduced them 3 1/2 to 1. This contrasts with the coast form of Douglas-fir in the Pacific Northwest where adventitious shoots appear to be more productive than branch turnups.[2]

Treatments favoring either turnups or shoots produce Christmas trees of nearly equal quality, but trees from turnups reach larger sizes earlier than do trees from shoots. About half of the merchantable trees from the stump treatments in this study were premium- or standard-grade, but one-third of the turnup trees reached the 10- and 12-foot class while none of the shoot trees reached these sizes.

The manager apparently has a fair amount of latitude in choosing the time to treat stumps. No differences could be detected in this study between stumps treated the same time as the original tree was cut or stumps treated as much as 3 years later. However, to assure that stump vigor is maintained, some growers feel that treatment should be delayed a year or more.

The logic behind stump treatment is sound. The inherent genetic characteristics that determined the quality of the original tree--for example, branch angle and needle color and density--can be relied upon to provide the same qualities in the turnups or shoots. Thus, the stumps not only produce Christmas trees sooner than could be grown from planted stock, but their quality is also predictable.

Stumps from open-grown trees should be treated for branch turnups. Such a stump can produce a Christmas tree, and in many cases, several trees before any comparable trees could be grown from natural or planted seedlings. The following can be recommended as guidelines:

1. Treat stumps of trees that have demonstrated desirable Christmas tree characteristics.

2. Cut the original tree above the second or third whorl of vigorous live branches.

3. Reserve as many as six or seven major branches to sustain the vigor of the stump. Favor two or more of these branches on alternate sides of the stump for turnup trees by removing branches that are competing with them for space. By favoring more than one turnup tree at a time, excessive leader growth can be more easily controlled.

4. Turnup trees may be basal pruned to maintain satisfactory internode length because they often grow too fast.

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[2]Personal communication with Bernard S. Douglass, State and Private Forestry, Region 6, USDA Forest Service.

Basal pruning has been one of the most controversial Christmas tree culture methods, and results of this study illustrate why. Even though all five of the different prunings substantially reduced the height growth (which presumably makes the crown appear denser), there appeared to be no corresponding overall increase in number, quality, or size of merchantable Christmas trees during the 10-year period. However, there did appear to be a trend toward increased production during the first 5-year period on trees that had been moderately pruned.

Douglass (1963) also found that height growth could be reduced by pruning. However, he cautioned that pruning is frequently overdone on lower-quality sites and results only in increasing the time required to grow a merchantable size tree.

Height growth and the corresponding internode length are generally not excessive on most sites suitable for Christmas trees in Montana. Areas where annual growth of most of the trees exceeds 16 inches are probably better suited for growing timber than they are for Christmas trees. However, pruning can be used to reduce the length of the internodes where height growth is excessive on areas dedicated to Christmas tree production.

Where pruning is needed:

1. Prune from the middle of the green crown, leaving two or three good whorls of lower branches for subsequent stump culture.

2. Prune at the following rates:

If	*Then*
Actual growth exceeds desired growth by	*Remove the following amounts of green crown*
(Percent)	*(Percent)*
25	33
50	50
75	60
100	66

3. Prune as often as necessary to maintain the desired internode length.

4. Shear to shape and increase the density of the crown. Kintigh (1965) found that shearing was one of the best cultural methods to use for increasing the quality of Douglas-fir Christmas trees.

5. Harvest cultured areas annually to assure maximum utilization of trees when they are ready.

6. After harvesting, culture the stump for branch turnup development.

Douglas-fir thickets provide an extensive source of small, medium-quality Christmas trees in Montana. For example, about 8 percent[3] of the trees in the original stand used for this study produced merchantable trees during the initial thinning or during the following 10-year period. However, over 95 percent of the trees were 2- to 4-feet tall and of standard quality or less.

[3]This is equivalent to about 1,000 trees per acre in the thickets but because the thickets are clumpy, the average per acre for an area as a whole would be considerably less.

Dominant and codominant trees of good and fair vigor are the source of nearly all the Christmas trees in thickets. Crown deterioration in the intermediate and suppressed trees is apparently severe enough to preclude their use for Christmas trees initially or in any reasonable period of time after that.

The Christmas tree grower's objectives largely dictate his choice of thinning. Heavy thinnings produce the most Christmas trees initially but light to moderate frequent thinnings produce more trees in subsequent harvests as well as maintain stands with a greater potential for future production. In thinning, badly deformed Douglas-fir trees, as well as trees of all other species, should be removed. All merchantable trees that appear to have reached their maximum development in quality and size should be harvested annually.

In summary, Christmas tree growers utilizing natural stands of Douglas-fir must recognize that they deal with extremely heterogeneous tree populations. Prescriptions must be based upon sound biological and economic principles applicable to each stand and individual tree. Culture techniques for Douglas-fir have been fairly well described (Wellner and Roe 1947, Burlison and Pitkin 1962, Douglass 1967), but the "professional touch" still will be needed to successfully prescribe the best combination of these techniques for optimizing Christmas tree production.

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